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THE ORIGIN OF PELAGIC LIFE.

(FROM PROF. W. K. BROOKS.)

Chapters VII and VIII of Brooks' Memoir on Salpa embrace a discusssion of this genus in its relation to the evolution of life, and in order to clearly present its position and significance in the economy of nature the author discusses at some length the conditions under which oceanic life has been evolved. He notes first that the marine animals are almost exclusively carnivorous. They prey upon each other to an almost incredible extent, and were it not for the extraordinary fertility of pelagic organisms the rapacity of the higher forms of life would bring about their own extermination. Mr. Brooks, in commenting on the abundance of marine life, instances the great schools of mackerel, the hunters of herring, which in turn swarm like locusts. In 1879, three hundred thousand river herring were landed by a single haul of the seine in Albemarle Sound; but the herrings feed upon copepods, each one consuming myriads every day. In spite of this destruction and the ravages of armies of medusæ, siphonophores and pteropods, the fertility of the copepods is so great that they are abundant in all parts of the ocean, and not only on the surface, for banks of them are sometimes a mile thick. On one occasion the Challenger steamed for two days through a dense cloud formed of a single species. But upon what do the copepods feed? And this brings the author to the important factors in the food supply of the animals of the ocean. The basis of all the life in the modern ocean is to be sought in the microorganisms of the surface. They consist of a few simple unicellular plants, and the globigerinæ and radiolaria which feed upon them. These organisms are so abundant and so prolific that they meet all demands made upon them. They are not only the fundamental food supply, but, according to the author, the primæval supply which has determined the whole course of the evolution of marine life.

Sameness of environment and lack of competition for space have tended to make pelagic plant life retain its primitive simplicity, but existing apparently under the same conditions is an infinite variety of animal life. How can this be accounted for? In tracing the phylogeny of Salpa, Mr. Brooks finds that the structure which is so well adapted for life on the high seas has come to it by the inheritance of peculiarities originally acquired by bottom animals in adaptation to the needs of a sessile life. In this connection the author states that the majority of the present pelagic animals have not been produced at the surface of the ocean by gradual evolution from a simple pelagic ancestor, but that part of their family history has been worked out by individuals who colonized upon or near the bottom, or along the sea shore, or upon the land, and the exceptions are all simple animals of minute size. He reviews the chief groups of metazoa to demonstrate this fact and gives, as notable exceptions, some of the veiled medusæ, a few of the primitive annelids, possibly, and the copepods among the crustacea. Among the higher forms, the fishes, which at first sight would seem to have been pelagic from the beginning, so admirably are they fitted for life in the open water, are found upon examination to be only secondarily adapted to a pelagic life, like the sea-birds and the cetaceans.

Mr. Brooks bases these statements on evidence from paleontology, from embryology, and from the structure and habits of living animals.

In discussing the conditions under which the primitive pelagic fauna lived, and the comparative results of pelagic and bottom environment upon marine life, the author points out that while the animals which first settled on the bottom probably did not secure more food than did their floating allies, they obtained it with less effort and were able to devote their surplus energy to growth and multiplication. The rapid multiplication led to crowding and competition, prevented the influx of newcomers from the open water, and finally resulted in the elaboration and specialization of the types of structure already established. Evolution was rapid, for life at the bottom introduced many and new opportunities for divergent modifications.

Another result was the escape of varieties from competition with their allies by flight from the crowded bottom to the open water above. The influence of these emigrants upon strictly pelagic forms is seen in the evolution at the surface of complicated forms like the siphonophores. But, on the whole, ocean space is so great and conditions of life in open water so easy that many of the pelagic organisms retain their primitive simplicity, existing simultaneously with the large and highly organized invaders from the shore and bottom.

The colonization of the bottom formed an important era in the evolution of marine life and the author devotes a section to a consideration of the characteristics of this primitive fauna of which the following is a summary:

"1. It was entirely animal, and it at first depended directly upon the pelagic food supply.

"2. It was established around elevated areas and in water deep enough to be beyond the influence of the shore.

"3. The great groups of metazoa were rapidly established from pelagic ancestors.

"4. There was a rapid increase in the size of the bottom animals and hard parts were quickly acquired.

"5. The bottom fauna soon produced development among pelagic animals.

"6. After the establishment of the bottom fauna, elaboration and differentiation among the representatives of each primitive type soon set in and led to the extinction of the connecting forms."

In comparing these characteristics with those of the earliest known fauna as sketched by Walcott, Mr. Brooks finds that in going backward toward the lower Cambrian he finds a closer and closer agreement with the biological conception of the primitive life at the bottom. And while he does not regard the Olenellan fauna as the first bottom fauna, since it contains forms secondarily adapted to pelagic life, such as pteropods, still, "a biologist must regard it as an unmistakable approximation to the primitive fauna of the bottom, beyond which life was represented only by simple and minute pelagic organisms."

Mr. Brooks' point of view, then, is that marine life is older than terrestrial; it has shaped itself in relation to its food supply; this food supply, the microorganisms referred to above, is the only form of life which is independent and it therefore must be the oldest; from these simple types the pelagic ancestors of all the great groups of metazoa were slowly evolved until the colonization of the bottom, when a rapid advancement took place; the present highly differentiated forms which constitute the ocean fauna are the descendants of the colonizers, while the lower pelagic forms are the lineal representatives of the primitive forms, some of which are slightly modified by the influence of the emigrants from the shore and bottom.